



# **Recommended Specifications For Portland Cement Pervious Pavement**

## **Foreword**

Portland Cement Pervious Concrete Pavements have become increasingly popular as a method to meet water quality water run off regulations throughout the Carolinas. The most predominate use is found in driveways and parking area paving applications. This abbreviated specification is presented as a recommended guide for light traffic paving loading.

Traditional Portland Cement Pavement testing procedures based on strength, air content and slump control are not applicable to this type of pavement material. As continued testing of this product yields test methods that are reproducible in the field and laboratory, these recommended specifications will be modified.

## **100. General Provisions**

**101. Scope of Work:** The Work to be completed under this contract includes the furnishing of all labor, materials and equipment necessary for construction of the proposed improvements in conformance with the plans and specifications.

### **102. References:**

- A. American Society of Testing and Materials
  - 1. ASTM C 29 "Test for Unit Weight and Voids in Aggregate."
  - 2. ASTM C 33 "Specification for Concrete Aggregates."
  - 3. ASTM C 42 "Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete."
  - 4. ASTM C 117 "Test Method for Material Finer than 75  $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing."
  - 5. ASTM C 138 "Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete."
  - 6. ASTM C 150 "Specifications for Portland Cement" (Types I or II only).
  - 7. ASTM C 1157 "Performance Specification for Hydraulic Cement"
  - 8. ASTM C 172 "Practice for Sampling Fresh Concrete."
  - 9. ASTM C 260 "Specification for Air-Entraining Admixtures for Concrete."
  - 10. ASTM C 494 "Specification for Chemical Admixtures for Concrete."



11. ASTM C 595 “Specifications for Blended Hydraulic Cements” (Type IP or IS only).
  12. ASTM C 618 “Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.”
  13. ASTM C 989 “Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.”
  14. ASTM C 1077 “Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.”
  15. ASTM D 448 “Specification for Standard Sizes of Coarse Aggregate for Highway Construction.”
  16. ASTM D 1557 “Tests for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10 Pound Rammer and 18-inch Drop.”
  17. ASTM E 329 “Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction.”
- B. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO T-180 “Moisture-Density Relations of Soils Using a 101 pound (454 kg) Rammer and an 18 in. (457 mm) Drop.”

**103. Contractor Qualifications:** The use of a Finishing Contractor who has successfully completed the CRMCA Pervious Concrete Installers Course is strongly recommended. Prior to award of the contract, the placing contractor shall furnish Owner/Engineer/Architect a statement attesting to qualifications and experience and the following:

1. A minimum of 2 completed Pervious Concrete projects with addresses.
2. Unit weight acceptance data.
3. In-situ pavement test results including void content and unit weight.
4. Sample of product (i.e. core or test panel).
5. Proposed equipment to be used for placement and compaction.

**104. Concrete Producer Qualification:** The use of a concrete producer who has successfully completed the CRMCA Pervious Concrete Installer/ Technician Course is strongly recommended.

**If the placing contractor and/or concrete producer have insufficient experience with Portland cement pervious concrete pavement as outlined in sections 103 and 104, the placing contractor shall retain an experienced**



**consultant who meets the requirements in sections 103 and 104 to monitor production, handling, and placement operations at the contractor's expense.**

#### **105. Test Panels:**

Regardless of qualifications, the contractor is to place, joint and cure two test panels, each to be a minimum of 225 sq. ft. at the required project thickness to demonstrate to the Architect's satisfaction that in-place unit weights can be achieved and a satisfactory pavement can be installed at the site location.

1. Test panels may be placed at any of the specified Portland cement pervious locations. Test panels shall be tested for thickness in accordance with ASTM C 42; void structure in accordance with ASTM C 138; and for core unit weight in accordance with ASTM C 140, paragraph 6.3.
2. Satisfactory performance of the test panels will be determined by:
  - Compacted thickness no less than 1/4" of specified thickness.
  - Void Structure: 20%  $\pm$  5% for low porosity, high strength  
30%  $\pm$  5% for high porosity, low strength
  - Unit weight plus or minus 5 pcf of the design unit weight.
3. If the requirements in item 2 above are not met, the test panel shall be removed at the contractor's expense and disposed of in an approved landfill.
4. If the test panel meets the above-mentioned requirements, it can be left in-place and included in the completed work.

**106. Concrete Mix Design:** Contractor shall furnish a proposed mix design with proportions of materials to Owner or Agent prior to commencement of work. The data shall include unit weights determined in accordance with ASTM C 29 paragraph 11, jigging procedure.

#### **200. Materials**

**201. General:** Locally available material having a record of satisfactory performance shall be used.



**202. Cement:** Portland Cement Type I or II conforming to ASTM C 150 or Portland Cement Type IP or IS conforming to ASTM C 595, or ASTM C 1157.

**202.1 Fly ash and Ground Iron Blast-Furnace Slag:** Fly ash conforming to ASTM C 618 may be used in amounts not to exceed 30 percent of total cementitious material. Ground Iron Blast-Furnace Slag conforming to ASTM C 989 may be used in amounts not to exceed 50 percent by weight of total cementitious material.

Note: When Class “F” Fly ash is used as part of the minimum cementitious content specified in Section 301, bond strength development may be delayed and additional curing time is required. See Section 505.

**203. Aggregate:** Use coarse aggregate (3/8 to No. 16) per ASTM C 33 or No. 89 coarse aggregate (3/8 to No. 50) per ASTM D 448. If other gradation of aggregate is to be used, submit data on proposed material to owner for approval.

**204. Air Entraining Agent:** Shall comply with ASTM C 260.

**205. Admixtures:**

Type A Water Reducing Admixtures – ASTM C 494.

Type B Retarding – ASTM C 494.

Type D Water Reducing/Retarding – ASTM C 494.

Also, a hydration stabilizer can be utilized and is recommended in the design and production of pervious concrete. This stabilizer suspends cement hydration by forming a protective barrier around the cementitious particles, which delays the particles from achieving initial set. The admixture’s primary function should be as a hydration stabilizer, however it must also meet the requirements of ASTM C 494 Type B Retarding or Type D Water Reducing/Retarding admixtures.

**206. Water:** Comply with ASTM C 94.

### **300. Proportions**

**301. Cement Content:** For pavements subjected to vehicular traffic loading, the total cementitious material content shall not be less than 600 lbs. per cu. yd.

**302. Aggregate Content:** The volume of aggregate per cu. yd. shall be a minimum 18 cu. ft. when calculated as a function of the unit weight determined in accordance with ASTM C 29 jigging procedure. Fine aggregate, if used, should not exceed 3 cu. ft. and shall be included in the total aggregate volume.

**303. Admixtures:** Shall be used in accordance with the manufacturer’s instructions and recommendations.



**304. Mix Water:** Mix water shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. (Mix water yielding a cement paste with a dull-dry appearance has insufficient water for hydration).

- Insufficient water results in inconsistency in the mix and poor bond strength.
- High water content results in the past sealing the void system primarily at the bottom and poor surface bond.

**305. Mix Design:** Using concrete materials acceptable to the Engineer, a tentative concrete mix shall be designed and tested for the consistency intended for use on the work and specified.

**High Porosity, Low Strength Modulus of Rupture** shall be as follows:

- Average strength such that at least 90% of tests are equal to or greater than 150 psi.
- Any individual test (minimum of 2 beams) shall be greater than 130 psi.

**Low Porosity, High Strength Modulus of Rupture** shall be as follows:

- Average strength such that at least 90% of tests are equal to or greater than 350 psi.
- Any individual test (minimum of 2 beams) shall be greater than 400 psi.

Modulus of Rupture tests shall be IAW with AASHTO T 23, and T97, except beams shall be filled in one lift (1 layer), compacted lightly during filling, and finished by rolling a hardened 6x12" concrete sample across it's surface and tested at 14 days. Unit weight (density) and % voids (porosity) shall be tested and reported.

#### **400. Sub-grade Preparation and Form-Work**

**401. Subgrade Material:** The top 6 inches shall be composed of granular or gravely soil that is predominantly sandy with no more than a moderate amount of silt or clay.

**402. Subgrade Permeability:** Prior to placement of Portland Cement Pervious Pavement, the subgrade shall be tested for rate of permeability by double ring infiltrometer, or other suitable test of subgrade soil permeability. The tested permeability must reasonably compare to the design permeability.



**403. Subgrade Support:** The subgrade shall be compacted by a mechanical vibratory compactor to a minimum density of 92% of a maximum dry density as established by ASTM D 1557 or AASHTO T 180. Subgrade stabilization shall not be permitted.

If fill material (embankment) is required to bring the subgrade to final elevation, it shall be clean and free of deleterious materials. It shall be placed in 8 inch maximum layers, and compacted by a mechanical vibratory compactor to a minimum density of 92% of a maximum dry density as established by ASTM D 1557 or AASHTO T 180.

**404. Subgrade Moisture:** The subgrade shall be in a moist condition (within +/- 3% of the optimum moisture content as determined by the modified compaction test ASTM D 1557 or AASHTO T 180).

**405. Forms:** Forms may be of wood or steel and shall be the depth of the pavement. Forms shall be of sufficient strength and stability to support mechanical equipment without deformation of plan profiles following spreading, strike-off and compaction operations.

## **500. MIXING, HAULING AND PLACING**

**501. Mix Time:** Truck mixers shall be operated at the speed designated as mixing speed by the manufacturer for 75 to 100 revolutions of the drum.

**502. Transportation:** The Portland cement aggregate mixture may be transported or mixed on site and should be used within one (1) hour of the introduction of mix water, unless otherwise approved by an engineer. This time can be increased to 90 minutes when utilizing the hydration stabilizer specified in Section 205.

**503. Discharge:** Each mixer truck will be inspected for appearance of concrete uniformity according to Section 304. Water may only be added by the concrete producer to obtain the required mix consistency. A minimum of 20 revolutions at the manufacturer's designated mixing speed shall be required following any addition of water to the mix. Discharge shall be a continuous operation and shall be completed as quickly as possible. Concrete shall be deposited as close to its final position as practicable and such that fresh concrete enters the mass of previously placed concrete. The practice of discharging onto subgrade and pulling or shoveling to final placement is not allowed.

**504. Placing and Finishing Equipment:** Unless otherwise approved by the Owner or Engineer in writing, the Contractor shall provide mechanical equipment



of either slip form or form riding with a following compactive unit that will provide a minimum of 10 psi vertical force. The pervious concrete pavement will be placed to the required cross section and shall not deviate more than  $\pm 3/8$  inch in 10 feet from profile grade. If placing equipment does not provide the minimum specified vertical force, a full width roller or other full width compaction device that provides sufficient compactive effort shall be used immediately following the strike-off operation. After mechanical or other approved strike-off and compaction operation, no other finishing operation will be allowed. If vibration, internal or surface applied, is used, it shall be shut off immediately when forward progress is halted for any reason. The Contractor will be restricted to pavement placement widths of a maximum of fifteen (15') feet unless the Contractor can demonstrate competence to provide pavement placement widths greater than the maximum specified to the satisfaction of the Engineer.

**505. Curing:** Curing procedures shall begin within 20 minutes after the final placement operations. The pavement surface shall be covered with a minimum six- (6) mil thick polyethylene sheet or other approved covering material. Prior to covering, a fog or light mist shall be sprayed above the surface when required due to ambient conditions (temperature, wind and humidity). The cover shall overlap all exposed edges and shall be secured (without using dirt or stone) to prevent dislocation due to winds or adjacent traffic conditions.

**Cure Time:**

1. Portland Cement Type I, II or IS – 7 days minimum.
2. Portland Cement Type I or II with Class F Fly ash (as part of the 600 lbs/cy minimum cementitious) or Type IP – 10 days minimum.
2. No truck traffic shall be allowed for 10 days (no passenger car/light trucks for 7 days).

**506. Jointing:** Control (contraction) joints shall be installed at 40-foot intervals for pavements designed for vehicular traffic. They shall be installed at a depth of  $1/4$  the thickness of the pavement. These joints can be installed in the plastic concrete or saw cut. If saw cut, the procedure should begin as soon as the pavement has hardened sufficiently to prevent raveling and uncontrolled cracking (normally after curing). Transverse construction joints shall be installed whenever placing is suspended a sufficient length of time that concrete may begin to harden. In order to assure aggregate bond at construction joints, a bonding agent suitable for bonding fresh concrete to existing concrete shall be brushed, rolled or sprayed on the existing pavement surface edge. Isolation (expansion)





joints will not be used except when pavement is abutting slabs or other adjoining structures.

## **600. Testing, Inspection and Acceptance**

**601. Laboratory Testing:** The owner will retain an independent testing laboratory. The testing laboratory shall conform to the applicable requirements of ASTM E 329 “Standard Recommended Practice for Inspection and testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction” and ASTM C 1077 “Standard Practice for Testing Concrete and Concrete Aggregates for use in Construction, and Criteria for Laboratory Evaluation” and shall be inspected and accredited by the Construction Materials Engineering Council, Inc. or by an equivalent recognized national authority.

The Agent of the testing laboratory performing field sampling and testing of concrete shall be certified by the American Concrete Institute as Concrete Field Testing Technician Grade I, or by a recognized state or national authority for an equivalent level of competence. The Concrete Producer shall endorse technicians testing proficiency of Portland Cement Pervious Concrete.

**602. Testing and Acceptance:** A minimum of 1 gradation test of the subgrade is required every 5000 square feet to determine percent passing the No. 200 sieve per ASTM C 117.

A minimum of one test for each day’s placement of pervious concrete in accordance with ASTM C 172 and ASTM C 29 to verify unit weight shall be conducted. Delivered unit weights are to be determined in accordance with ASTM C 29 using a 0.25 cubic foot cylindrical metal measure. The measure is to be filled and compacted in accordance with ASTM C 29 paragraph 11, jiggling procedure. The unit weight of the delivered concrete shall be  $\pm 5$  pcf of the design unit weight.

Test panels shall have two cores taken from each panel in accordance with ASTM C 42 at a minimum of seven (7) days after placement of the pervious concrete. The cores shall be measured for thickness, void structure and unit weight. Untrimmed, hardened core samples shall be used to determine placement thickness. The average of all production cores shall not be less than the specified thickness with no individual core being more than  $\frac{1}{2}$  inch less than the specified thickness. After thickness determination, the cores shall be trimmed and measured for unit weight in the saturated condition as described in paragraph 6.3.1 ‘Saturation’ of ASTM C 140 “Standard Methods of Sampling and Testing Concrete Masonry Units”. The trimmed cores shall be immersed in water for 24 hours, allowed to drain for one (1) minute, surface water removed with a damp cloth,





then weighed immediately. Range of satisfactory unit weight values is  $\pm 5$  pcf of the design unit weight.

After a minimum of 7 days following each placement, three cores shall be taken in accordance with ASTM C 42. The cores shall be measured for thickness and unit weight determined as described above for test panels. Core holes shall be filled with concrete meeting the pervious mix design.

In lieu of cores a Pave Quality Indicator (PQI), manufactured by Trans Tech Systems, Inc. can be used to determine the density and porosity (quality) of in place Pervious Concrete Pavement.

\*\*\*SPECIAL NOTE: This information is intended to be used by the design professional competent to evaluate its significance and limitation and who will accept the responsibility for its proper application. CRMCA disclaims any and all responsibility for any other use of the information supplied herein. \*\*\*



1805 J.N. Pease Place  
Charlotte, NC 28262